Implementing A New Manufacturing Vision

Challenges, Mechanisms, Partnerships and Lessons Learned

Ben Wang | Georgia Tech

Outline

- Manufacturing is a national imperative
- GT thought leadership at all levels
- Snapshots of grand challenges & emerging manufacturing innovations
- A model for the factory of the future

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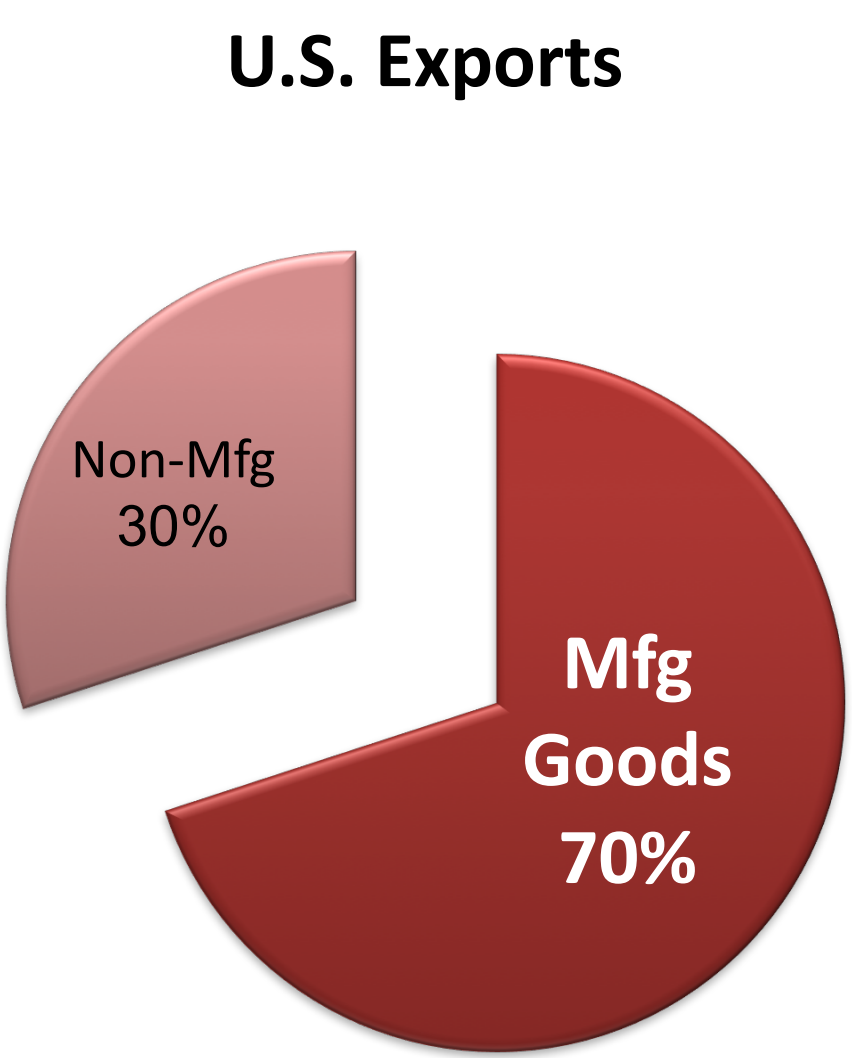
Why Manufacturing?

- Major wealth creator
- Effective return on investment
- Dominant innovation driver

Exports Create Wealth for the U.S.



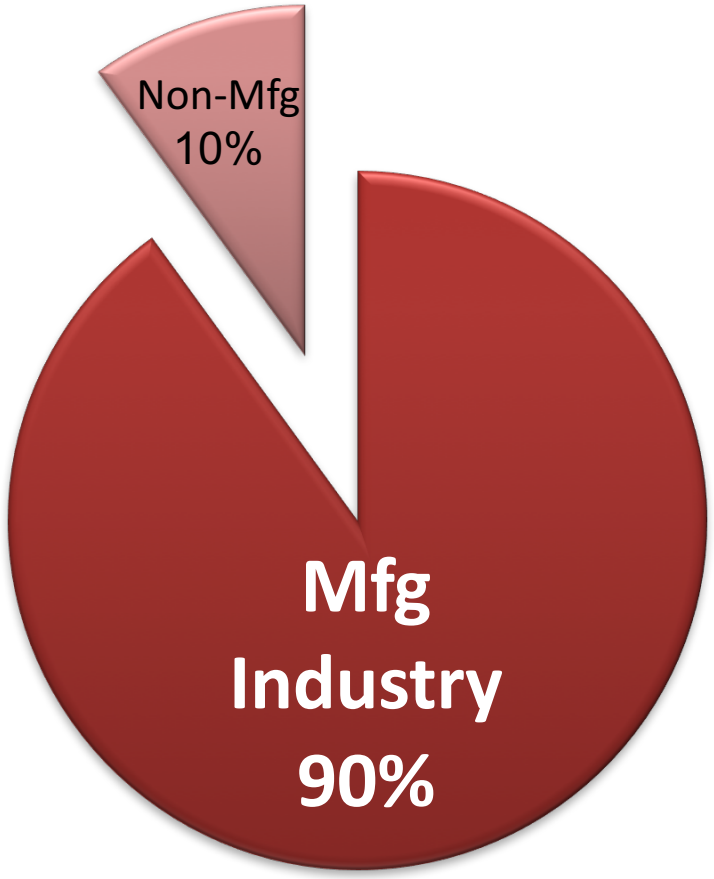
Excellent Return on Investment

$1 investment
In manufacturing

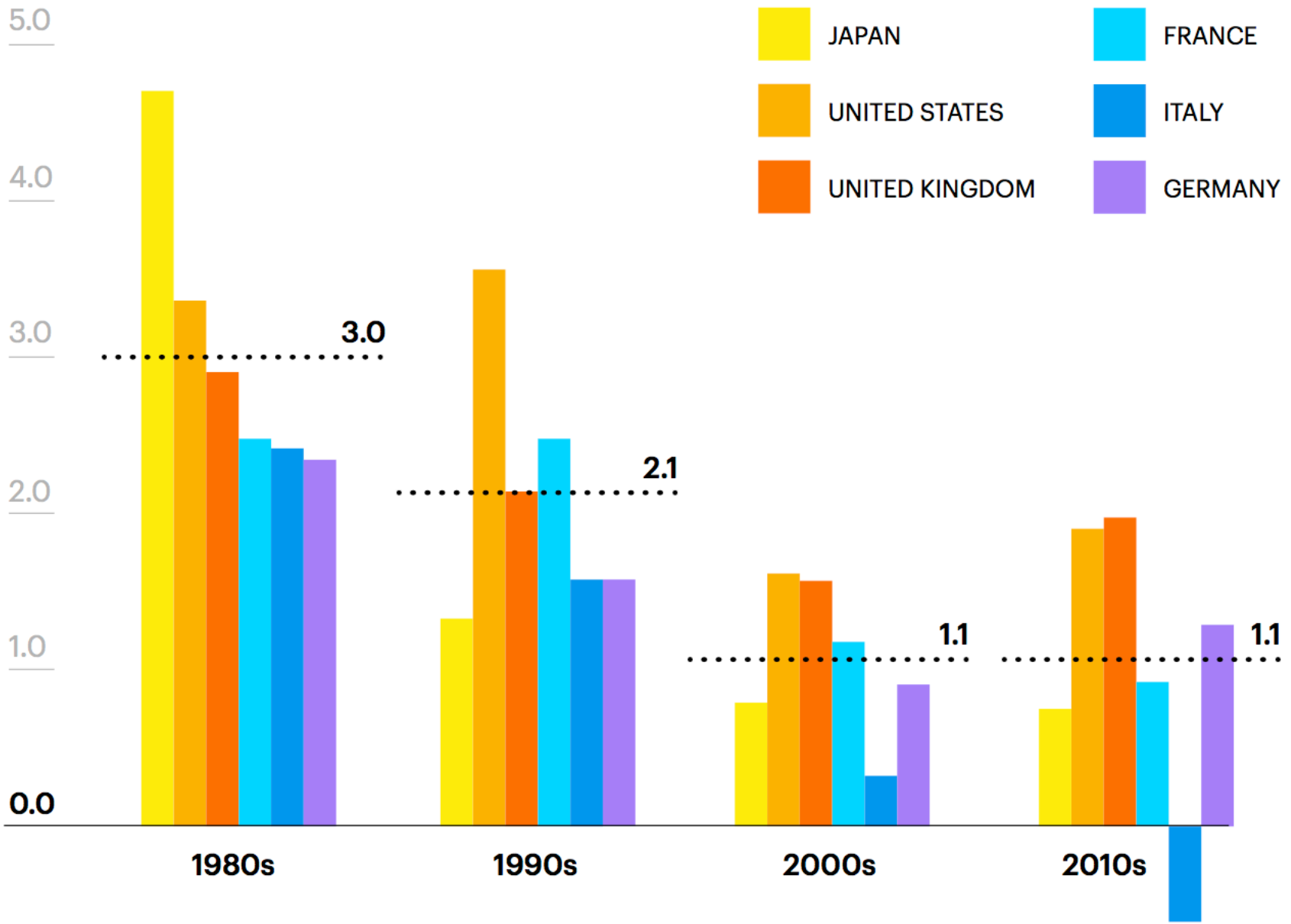
$2.48 economic activity

Manufacturing Drives Innovation

U.S. Patents



Since the 1980s, GDP growth has steadily slowed in many large economies.

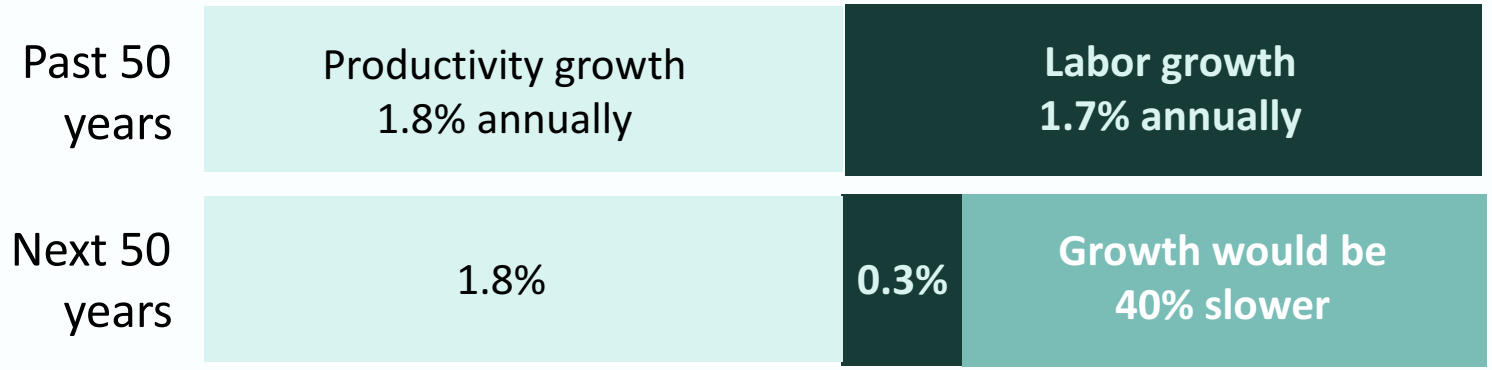


Why AI is the future of growth, Accenture, 2016

Innovation-driven GDP growth will be KEY
- The productivity imperative -

The global growth challenge of the next 50 years

In the past 50 years, GDP growth has been achieved equally by increasing productivity and labor, but this is changing



Even if productivity growth continues, labor expansion will slow sharply, cutting GDP growth

Global Growth, McKinsey January 2015

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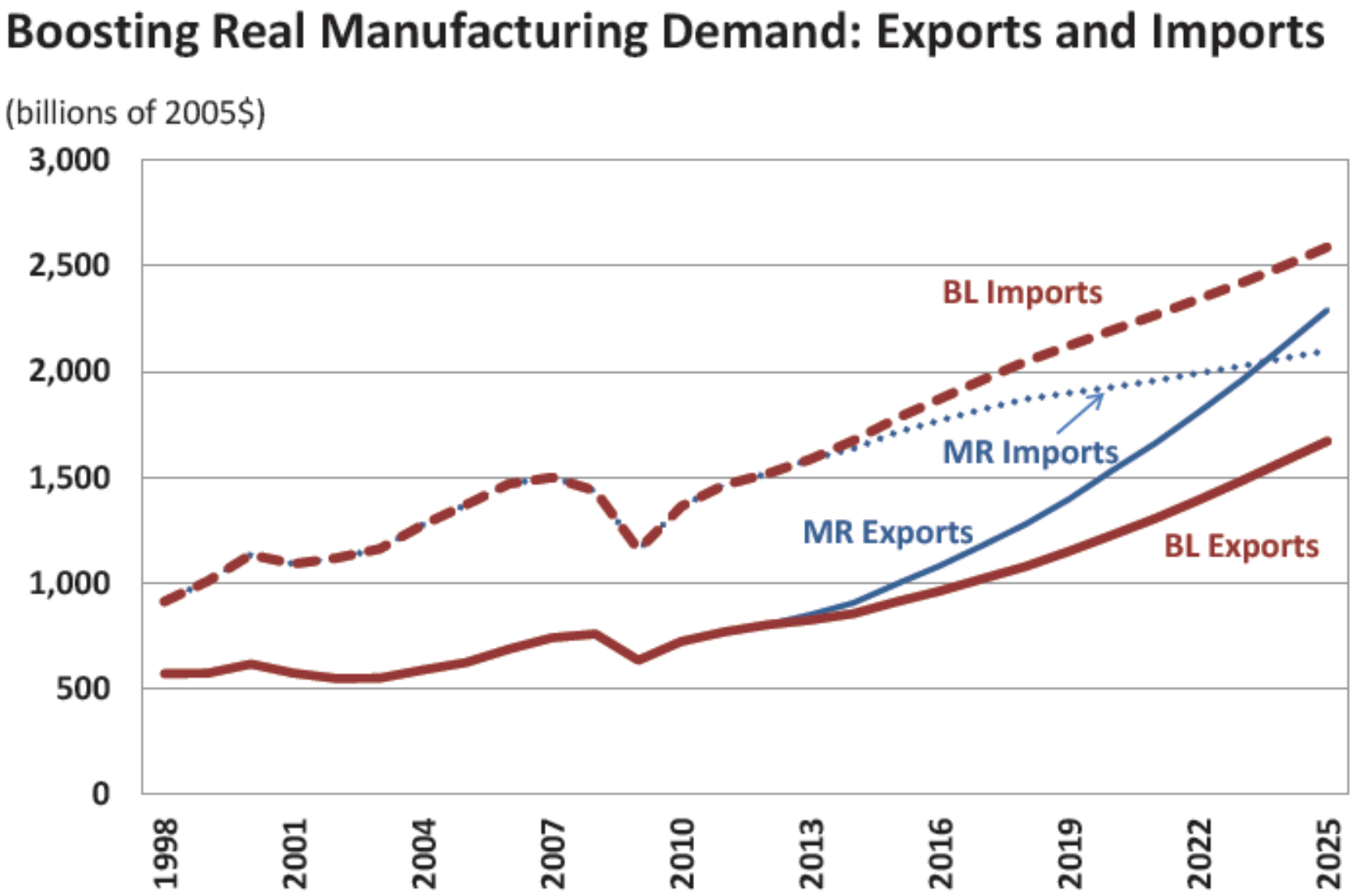
Advanced Manufacturing Partnership

Carnegie Mellon, Georgia Tech, Michigan, MIT, Stanford, UC Berkeley

Allegheny Technologies, Caterpillar, Corning, Dow, Ford, Honeywell, Johnson & Johnson, Intel, Northrop Grumman, P&G, Stryker, UTC

There is Hope – The Inforum Model



The Manufacturing Resurgence:, The Aspen Institute, 2013

REPORT TO THE PRESIDENT ON ENSURING AMERICAN LEADERSHIP IN ADVANCED MANUFACTURING

Executive Office of the President
President's Council of Advisors
on Science and Technology

JUNE 2011

A NATIONAL STRATEGIC PLAN FOR ADVANCED MANUFACTURING

Executive Office of the President
National Science and Technology Council

FEBRUARY 2012

REPORT TO THE PRESIDENT ON CAPTURING DOMESTIC COMPETITIVE ADVANTAGE IN ADVANCED MANUFACTURING

Executive Office of the President
President's Council of Advisors on
Science and Technology

JULY 2012

NATIONAL NETWORK FOR MANUFACTURING INNOVATION: A PRELIMINARY DESIGN

Executive Office of the President
National Science and Technology Council
Advanced Manufacturing National Program Office

JANUARY 2013

REPORT TO THE PRESIDENT ACCELERATING U.S. ADVANCED MANUFACTURING

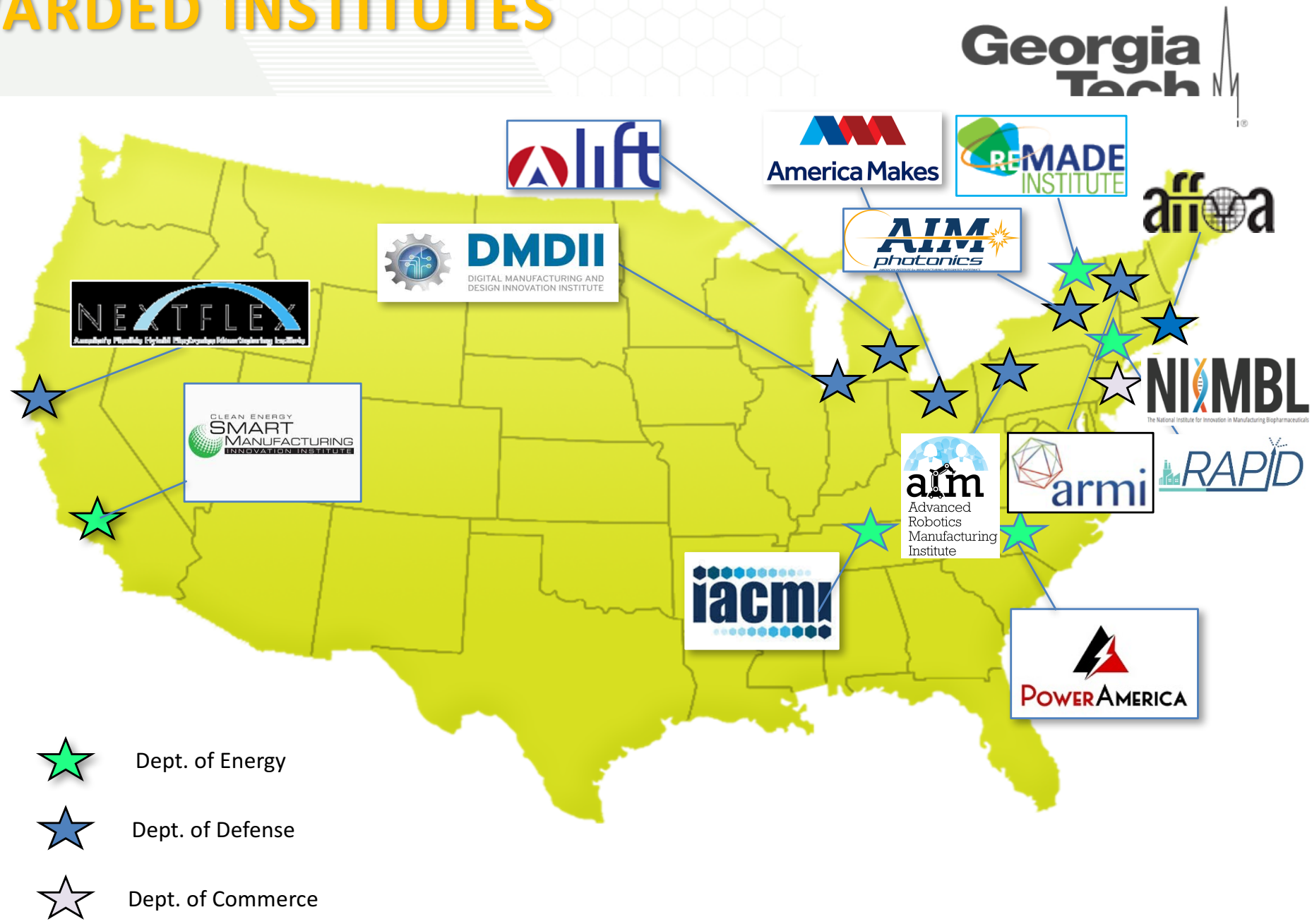
Executive Office of the President
President's Council of Advisors on
Science and Technology

October 2014

AMP identifies 11 top cross-cutting technologies

- Advanced forming and joining technologies
- Additive manufacturing
- Advanced materials design, synthesis and processing
- Advanced manufacturing and testing equipment
- Advanced sensing, measurement and process control
- Biomanufacturing and bioinformatics
- Flexible electronics manufacturing
- Industrial robotics
- Nanomanufacturing
- Sustainable manufacturing
- Visualization, informatics, and digital manufacturing technologies

AWARDED INSTITUTES



MANUFACTURING USA INSTITUTES

	3D Printing	Digital Manufacturing	Lightweight Materials	Advanced Composites	Power Electronics	Integrated Photonics	Flex Hybrid Electronics	Revolutionary Fibers and Textiles
Federal 5 yr. Funding	$50M ($30M)	$70M	$70	$70M	$70m	$100M	$75M	$70m
Industry Match	$39M 1.3 : 1	$106M 1.51 : 1	$78m 1.11 : 1	$180M 2.57 : 1	$70m 1:1	$350M 3.5 : 1	$75M 1.28 : 1	2.5:1
Institute Lead: NFP*	America Makes **(NCDMM*)**	Digital Manufacturing and Design Institute **(UI Labs*)**	Light Weight Innovations for Tomorrow **(EWI*)**	Institute for Advanced Composites Manuf Institute **(UTK*)**	Power America **(NC State*)**	AIM Photonics **(Research Foundation SUNY*)**	NextFlex **(Flex Tech Alliance*)**	Advanced Functional Fabrics of America **(MIT*)**
Collaborators	Industry 50 Univ. 28 Other 16	Industry 41 Univ. 23 Other 9	Industry 35 Univ. 17 Other 25	Industry 41 Univ. 23 Other 9	Industry 18 Univ. 7 Other	Industry 27 Univ. 16 Other 22	Industry 14 Univ. 12 Other 6	Industry 16 Univ. 31 Other 72
Technology Focus Areas	Additive Mfg.	Digital "Thread"	Lt. Wt. Metallics	Low Cost FRP Composites	WBG Power Elec	Integrated Photonics	Flexible Electronics	Technical Fabrics /Garments
Lead Gov. Agency	DoD USAF/ AFRL	DoD ARMY/ AMRDEC	DOD/ NAVY ONR	DOE Adv. Mfg. Office	DOE Adv. Mfg. Office	DoD AFRL	DoD/USAF/ AFRL	DoD/ Army NSRDC

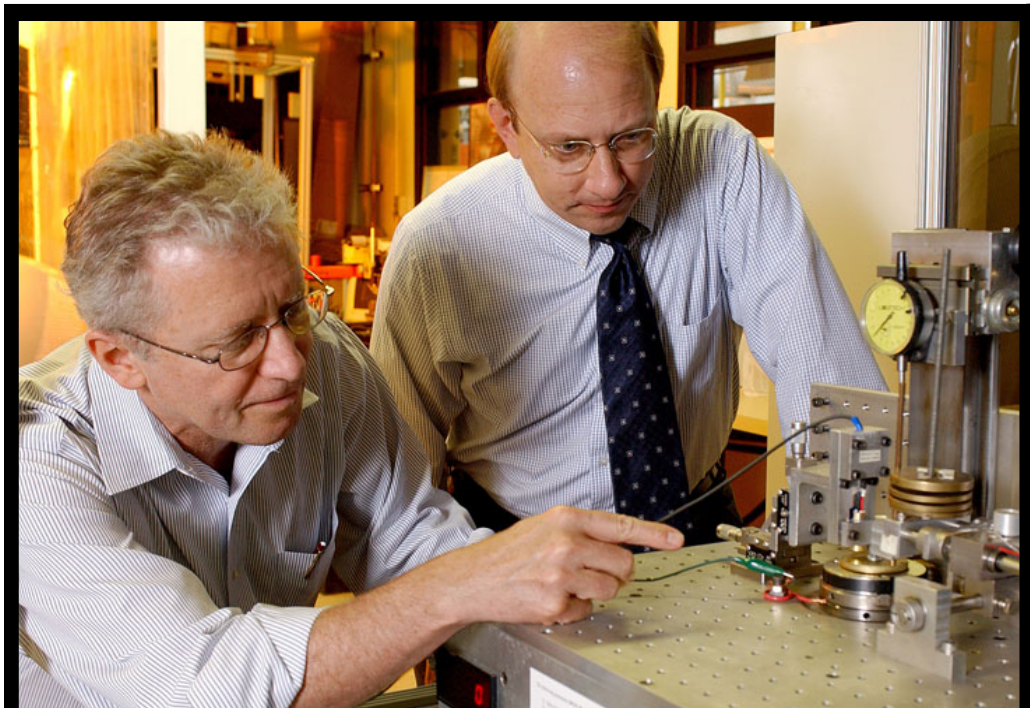
MANUFACTURING USA INSTITUTES

	Advanced Tissue Bio-Fabrication	Smart Manufacturing	Collaborative Robotics	NIST Open Call	Process Intensification	Sustainability / Reuse
Federal 5 Year Funding	$80m	$70m	$80m	$70M	$70m	$70M
Industry Match	$214M 2.7:1	$140M 2:1	$173M 2.2:1	$129M 1.8:1	$2m in-kind	$70M 1:1
Institute Lead: NFP*	**Advanced Regenerative Manuf. Institute (ARMI*)**	**Smart Manufacturing Leadership Coalition (SMLC*)**	**Advanced Robotics Manufacturing (Carnegie Mellon*)**	National Institute for Innovations in Manufacturing of Biopharma **(U Del*)**	Rapid Adv. in Process Intensification Deployment **(AICHE*)**	**Sustainable Manufacturing Innovation Alliance (SAII*)**
Collaborators	Industry: 47 University:26 Other: 14	Industry: TBD University: TBD Other: TBD	Industry: 123 University: 40 Other: 64	Industry: 85 University: 35 Other: 20	Industry: University: Other: 130 partners	Industry: University: Other: 100 partners
Technology Focus Area	Regenerative Medicine; Tissue Fab	Integrated Sensor, Control, and Platform Modeling	Collaborative Robotics, Robot Control, Sensing	Precision Medicine, accelerated biopharma manuf, standards dev	Modular chemical process intensification	Recycling and Remanufacture Separation of mixed mat, disposal meth.
Lead Gov. Agency	DoD	DoE	DoD	NIST	DoE	NIST

GT Major Decision Affecting Manufacturing

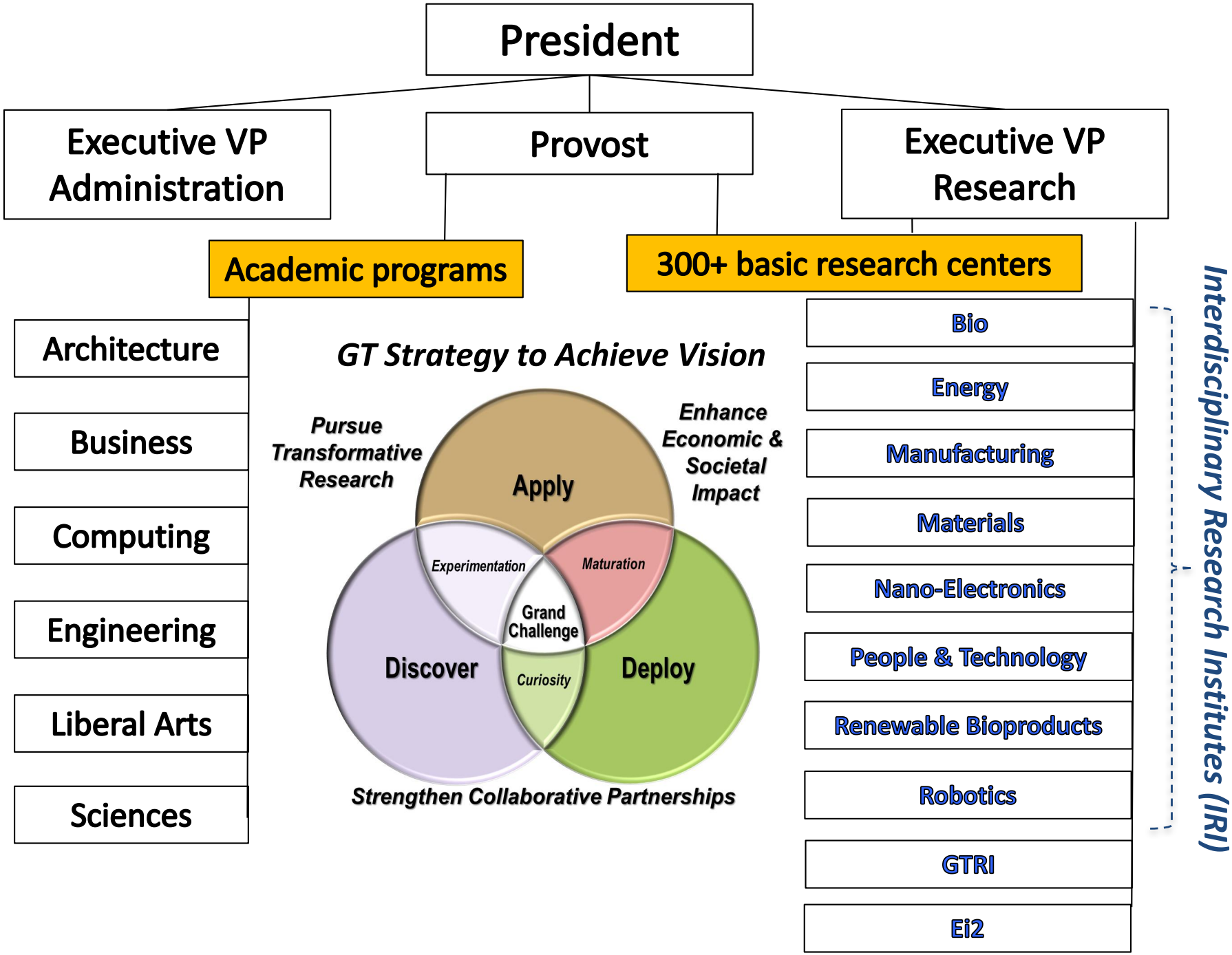
1991: State of Georgia created Manufacturing Research Center (MaRC) at Georgia Tech

- Through a successful private-public partnership
- 20+ years of proven leadership and contribution in industrial, manufacturing and materials engineering

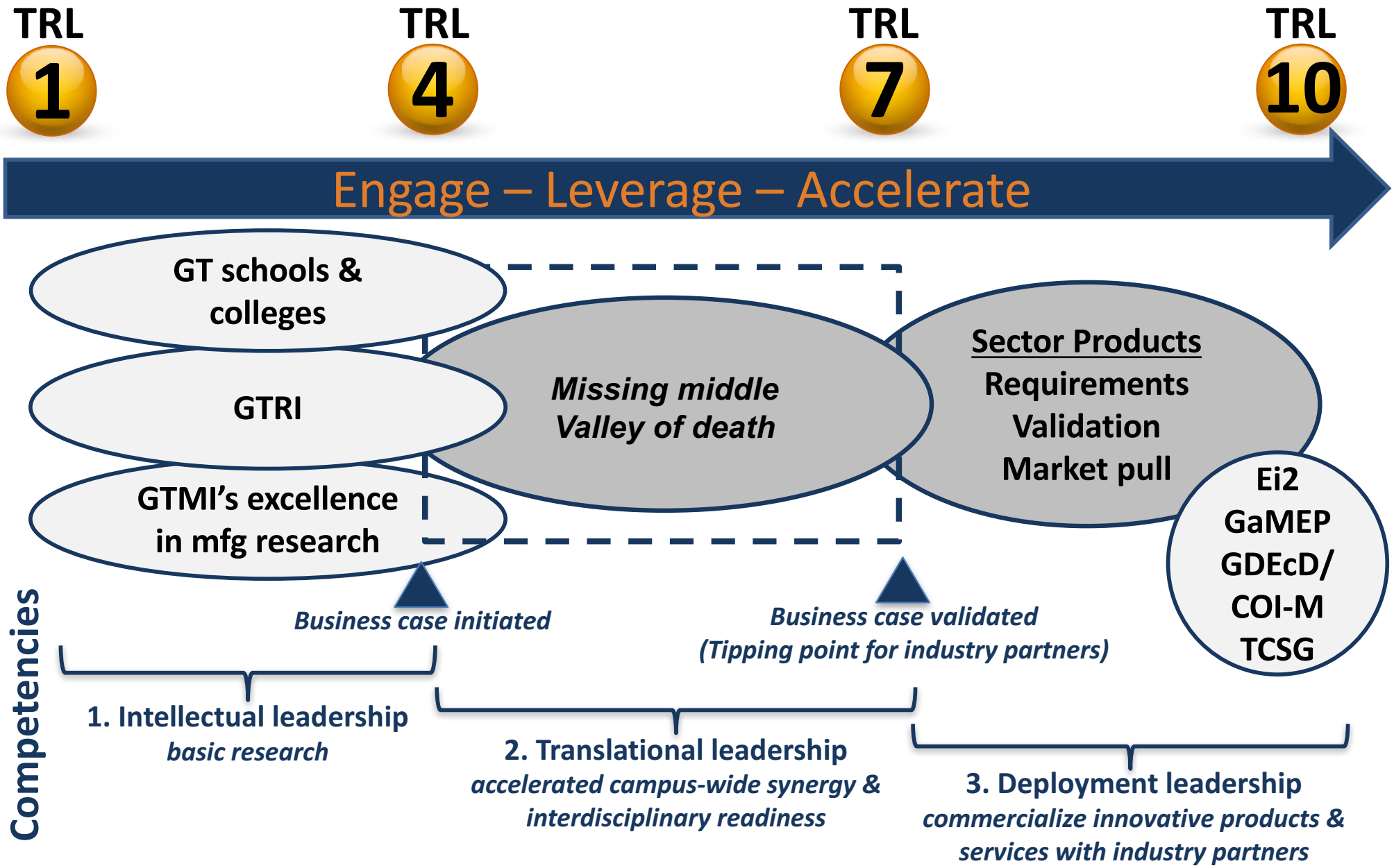



Georgia
Tech
Manufacturing
Institute

Capturing Innovation Impact



The Strategic Framework for GTMI



Prestigious Boeing Supplier of the Year Award

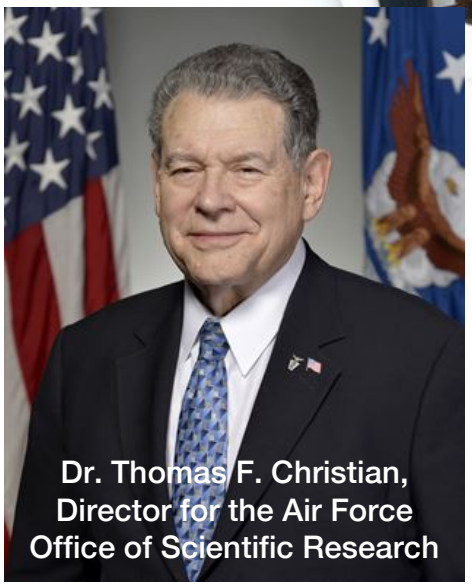
Recent Visitors

Impact on national policy decisions!


German Foreign Affairs Minister Frank-Walter Steinmeier


Mary Carpenter, legislative assistant to Congressman Jack Kingston


Dr. John Holdren, science advisor to President Obama


Dr. Thomas F. Christian, Director for the Air Force Office of Scientific Research


Admiral James A. "Sandy" Winnefeld, Jr., Vice Chairman of the Joint Chiefs of Staff


Chris Carr, former chief of staff to U.S. Senator Johnny Isakson Commissioner, GDEcD

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Sustainable Design & Manufacturing

Additive Manufacturing

Bio-Manufacturing

Supply Chain & Logistics

Clean Energy

Public Policy

Composites/ Nano-Composites Manufacturing

Precision Machining

Enterprise Innovation Institute

IoT for Manufacturing

Model-Based Systems Engineering

Flexible Automation

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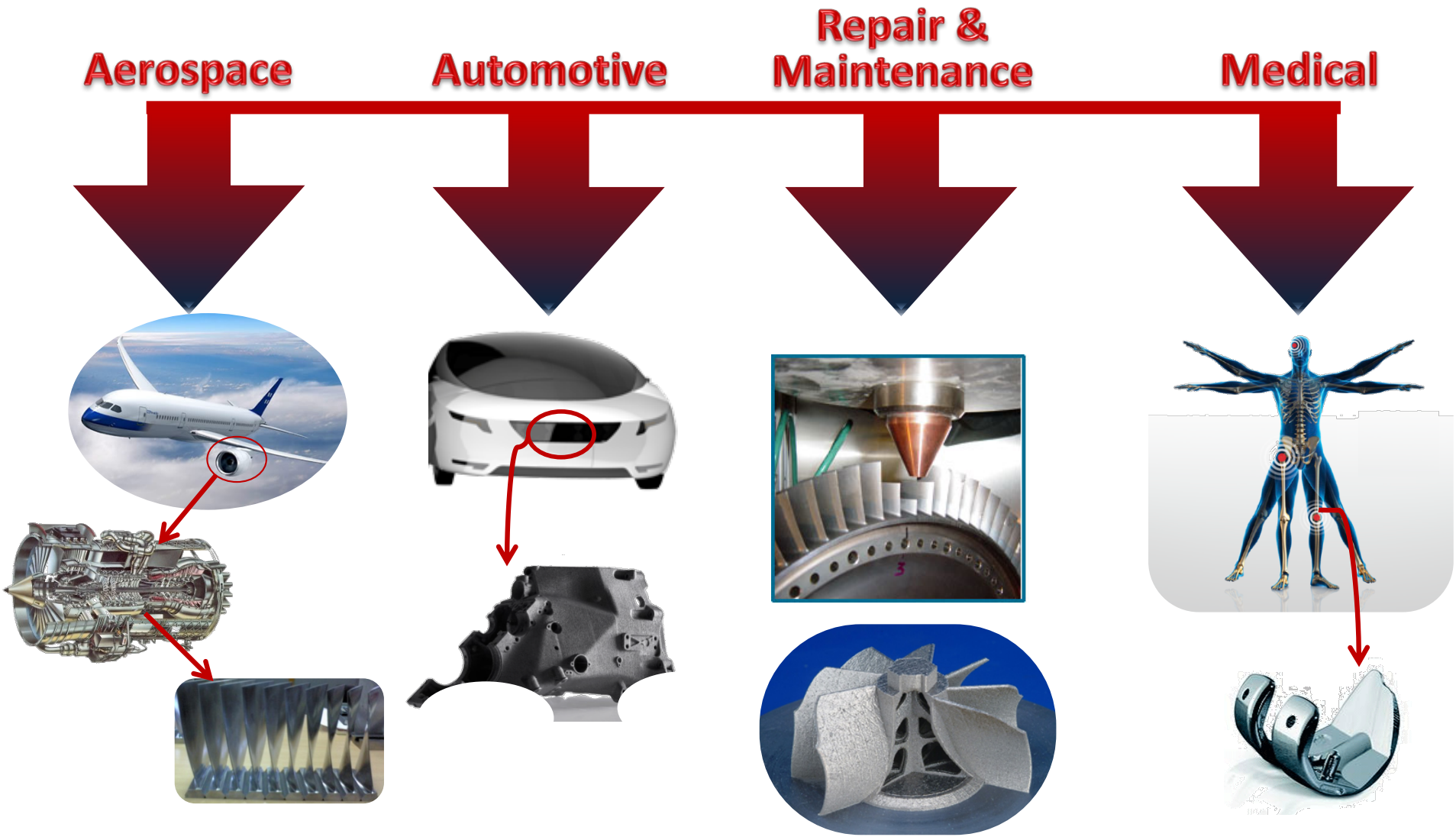
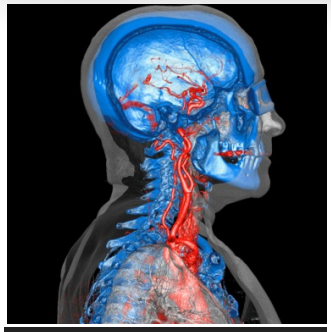
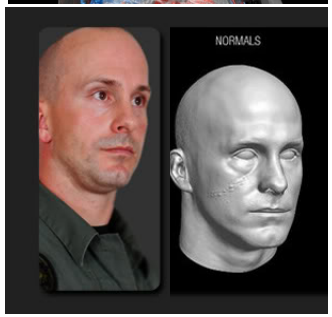
3D printing applies to many sectors

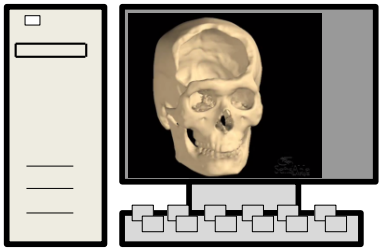


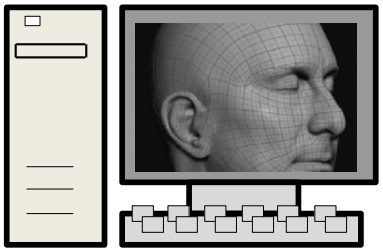
3D printing medical solution workflow

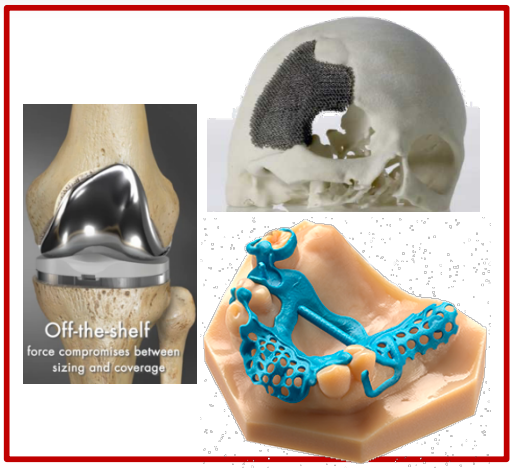
Engagement of medical doctors and staff at every step

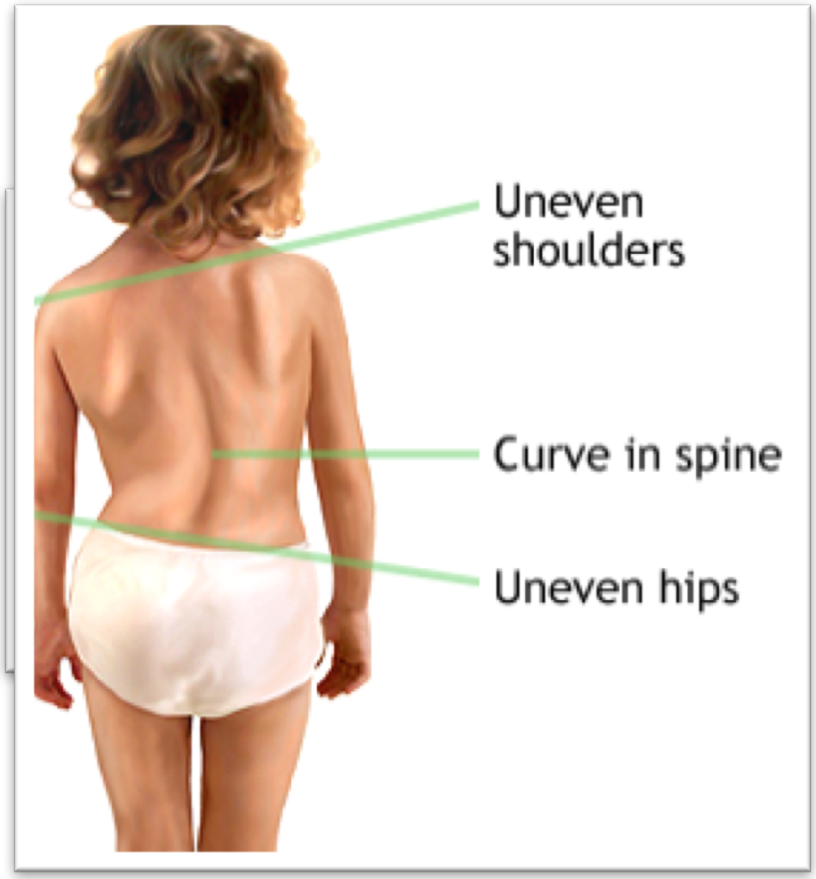






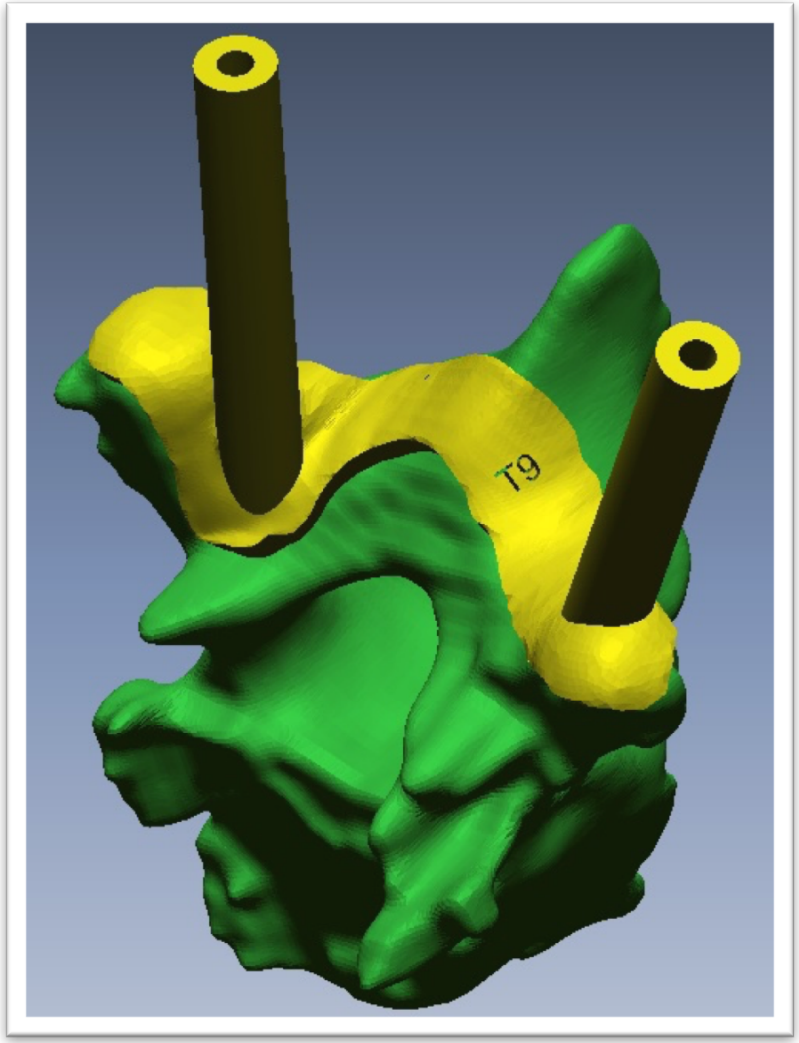




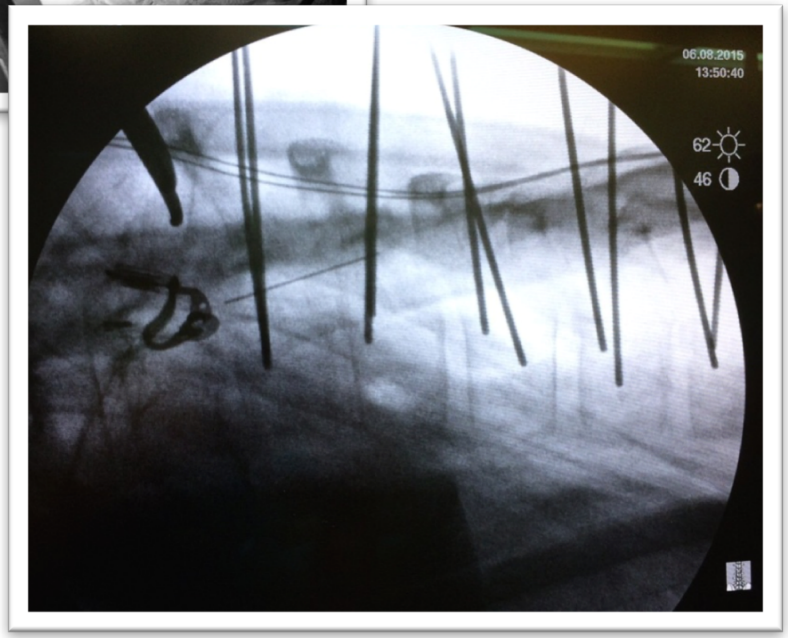

Uneven shoulders
Curve in spine
Uneven hips

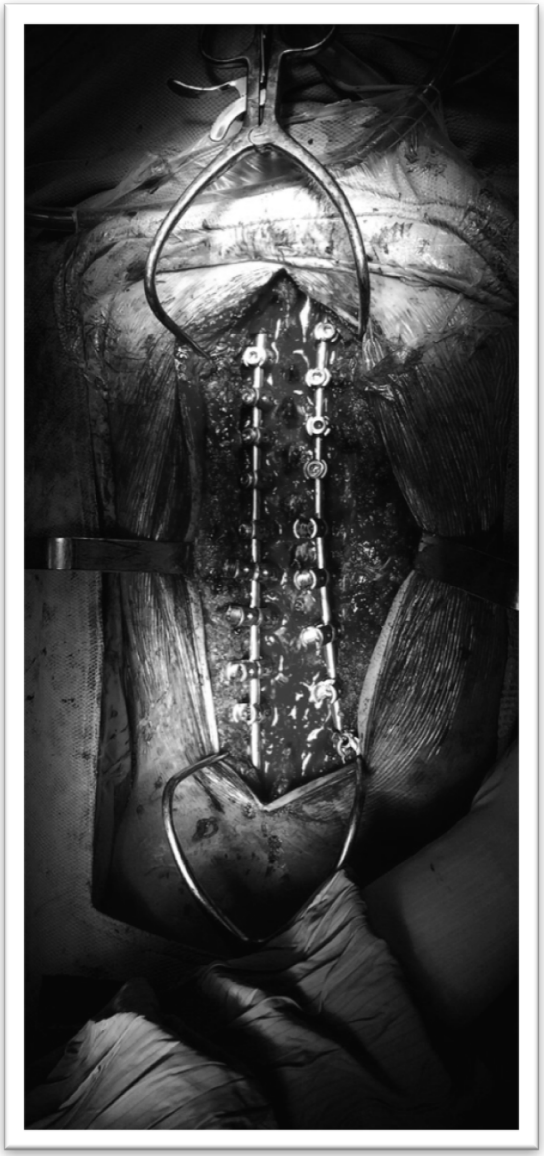
Spine Curvature Disorders

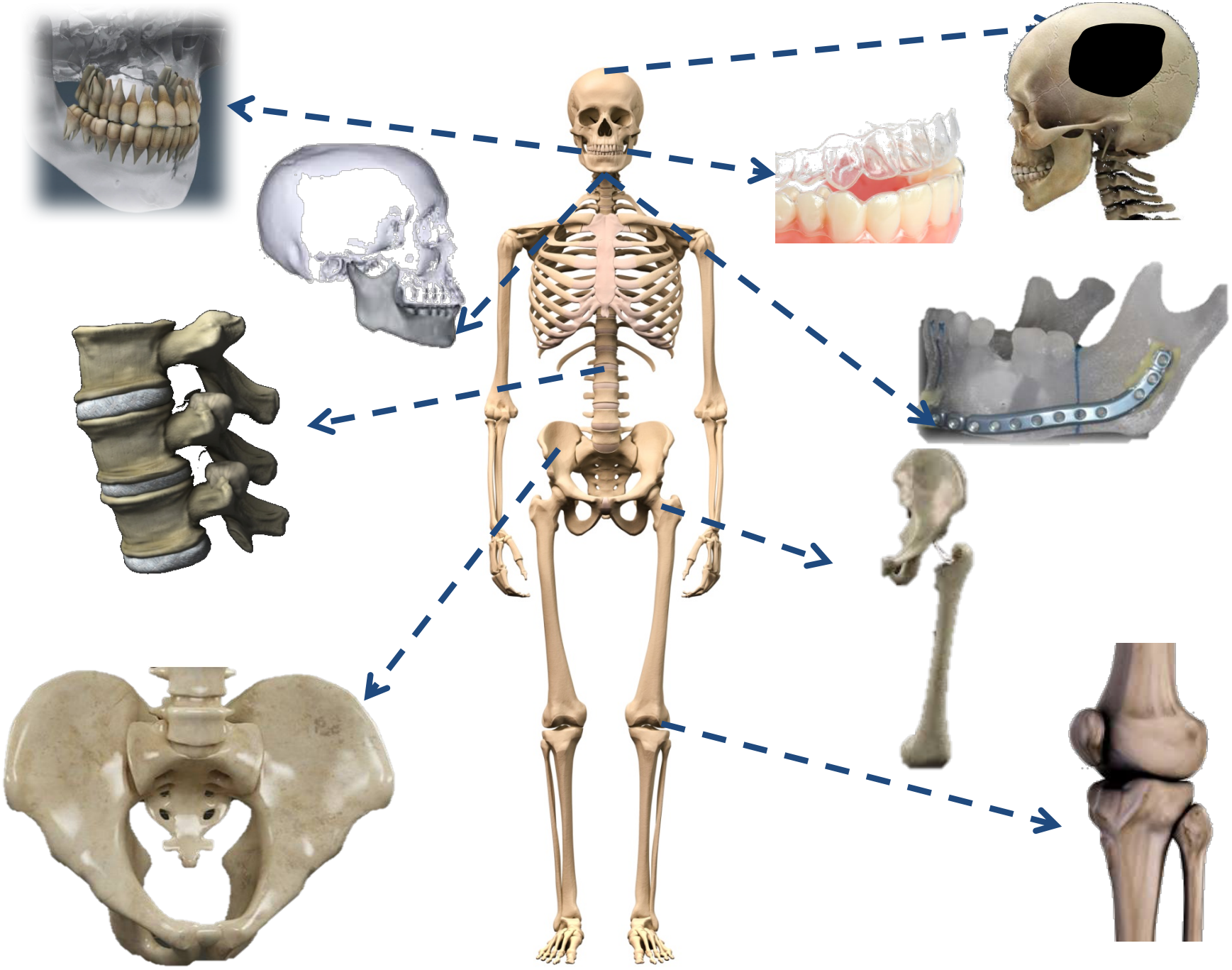
Designing Patient Matched Surgical Guides and Pre-op Simulations



Successful Clinical Cases







What we do now is primitive compared to what it can be and should be

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Flexible Automation

The lingering legacy of Deepwater Horizon *pp. 11 & 22*

The future of human genome editing *p. 36*

Drilli antiv

Science

SPECIAL ISSUE

Cancer Immunology and Immunotherapy

APRIL 4, 2016

TIME

What if your immune system could be taught to kill cancer?

Inside the brutally selective, hugely expensive, lifesaving trials of immunotherapy.

By Alice Park

Who Cares

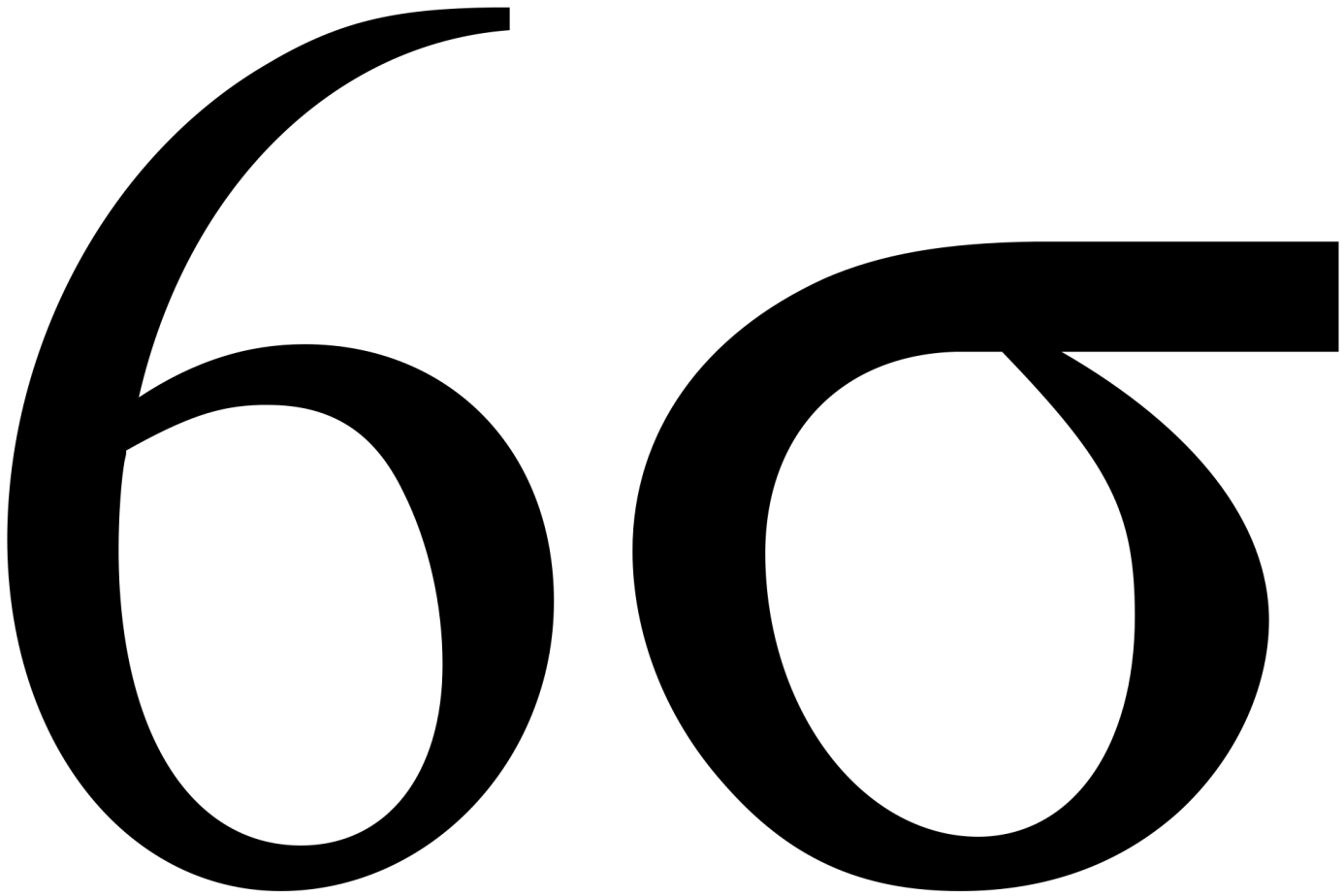
- **Currently incurable diseases: neurological, cardiovascular, inflammatory,…**
- **New tools and platforms for diagnostics, drug discovery, tissue repairs,…**
- **Aging population**
- **Cost of healthcare & economic impact**

Production Scale-up

10,000 – 50,000 cells

1,000,000,000^{+} cells

Product Quality



3.4 defects in 1,000,000 cells → 34,000 bad cells in each treatment NOT ACCEPTABLE

Product Cost

- Way too expensive ~ $100,000 per dose
- High production cost due to low yield
- Some cells take months to grow
- S&H sometimes costs more than production

Target cost per dose: $1,000-$5,000

Cell Manufacturing Consortium

NIST
National Institute of Standards and Technology

AMTECH
Advanced Manufacturing Technology Consortia

Competitive Planning Grants to:
establish and strengthen industry-focused research consortia,
develop shared vision technology roadmaps of industry's needs.

... aims to position the United States as the leading developer of cell-manufacturing technologies and the chief authority on cell manufacturing standards, worldwide.

Georgia Research Alliance

Aruna Biomedical, Celgene Cellular Therapeutics, Cellular Dynamics International, Georgia Inst of Technology, North Carolina State Univ, RoosterBio, Univ of California Berkeley, Univ of Georgia, Univ of Wisconsin

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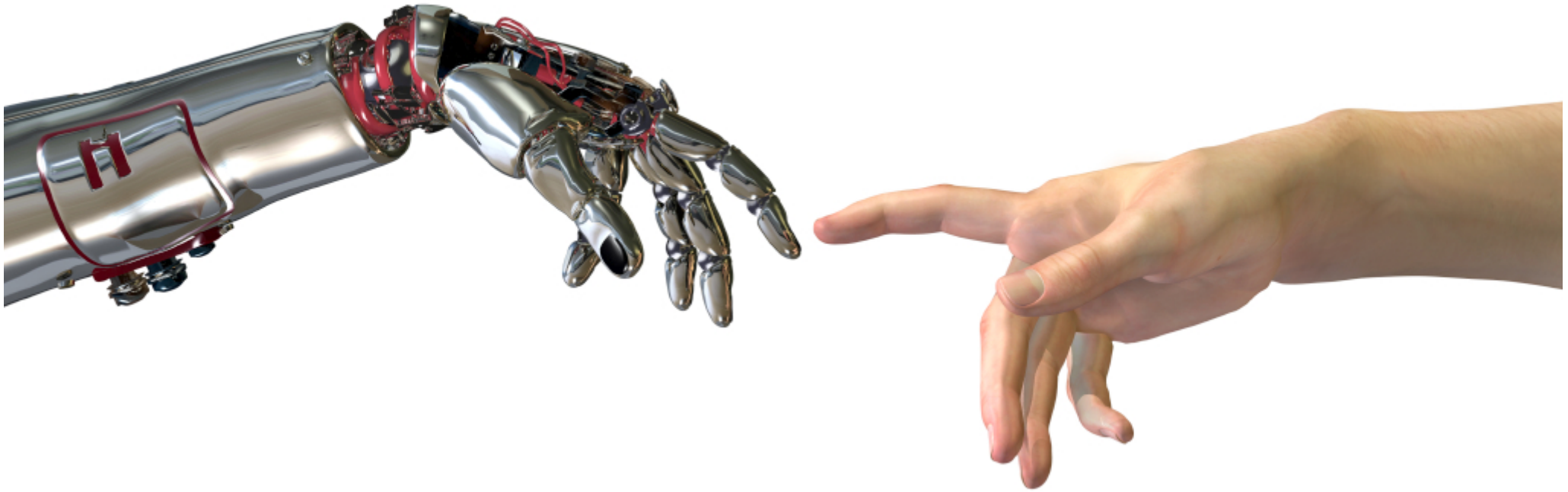
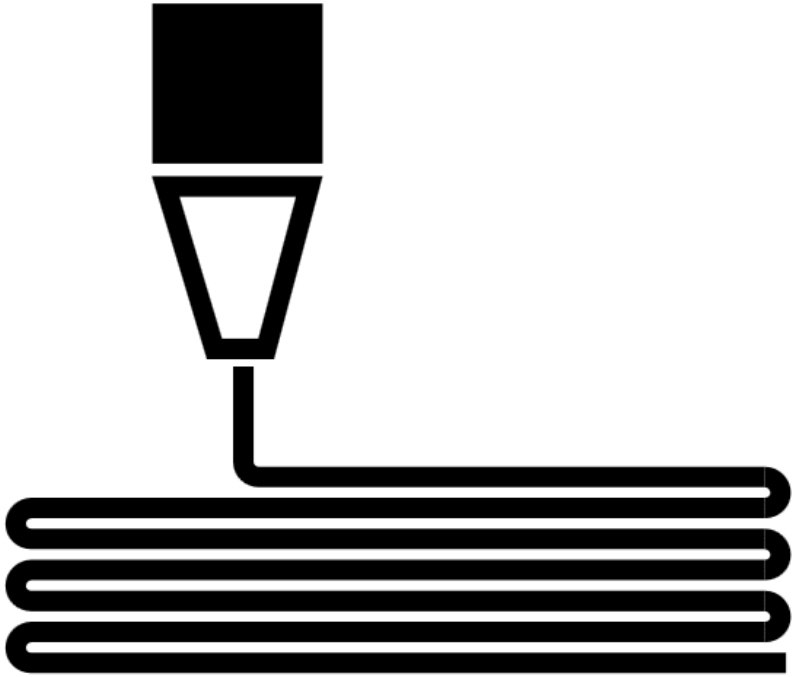
M16
S12
K11






CPS
Hybrid Manufacturing System

Challenges of implementing new manufacturing technologies

- Re-defining “manufacturing”
- Interfaces
- Standards
- Cybersecurity
- Supply chain innovation (small & medium sized enterprises, SMEs)
- Monetizing investment in new manufacturing technologies
- Workforce training & education

Concluding Remarks

Manufacturing of the future is innovation-rich, value-driven focusing on high value-added sectors

Convergence of advanced manufacturing and high-value service requires new business models and global partnerships

Green (sustainable) manufacturing is the only way to harmonize economic growth with the environment and society

Georgia Tech is a global leader in advanced manufacturing and innovative materials

Georgia Tech has a robust pipeline of manufacturing and materials technologies for the global market

Georgia Tech Manufacturing Institute catalyzes and accelerates transition of advanced technology from research lab to market